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ABSTRACT

A discussion is presented of the importance of science in the school program, the objectives of science teaching, and facilities for science instruction. Descriptions are then presented regarding the size and facilities necessary for the general science room, the darkroom, the biology room, the physics room, and the chemistry room. Two diagrams and floor plans are included; one is of the general purpose room and the other is of the preparation storage area for that room. (FS)

Planning
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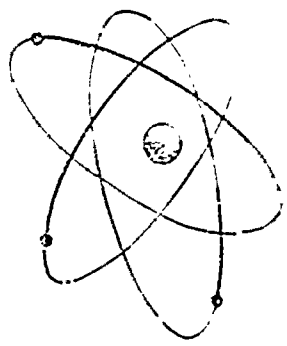

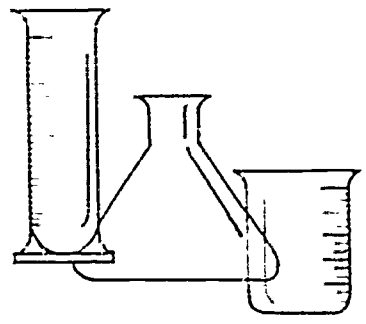

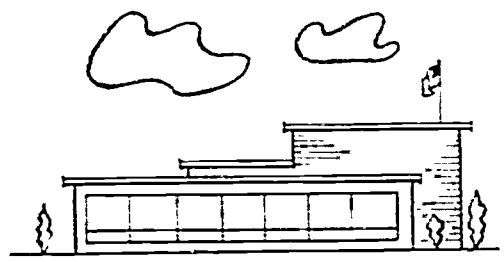

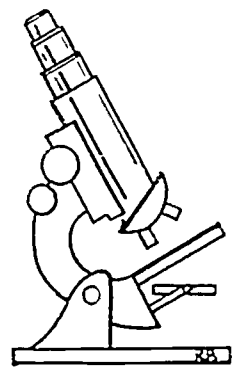

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INTRODUCTION

Planning Science Facilities for Secondary Schools is designed to help local school people and architects in the preparation of plans for new secondary schools and for improving existing facilities.

Science is a subject in which there is much individual experimentation. This naturally requires more space within the classroom as well as space to store materials to be studied and equipment with which to study.

This manuscript was prepared by Leslie Edsall, supervisor and teacher in the Bethlehem Central School District, under the direction of Hugh Templeton, supervisor of science education, and his staff and Basil Hick of the Division of School Buildings and Grounds.

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SCIENCE FACILITIES FOR SECONDARY SCHOOLS

Purpose of the Publication

It is the purpose of this publication to assist educators in their approach to planning new school buildings and facilities of instruction. While the primary objective is assistance in planning the science room, some suggestions as to facilities for instruction and their arrangement will be made in the hope that the total planning task will be lightened. Attention will also be given to auxiliary rooms and areas which are essential to a full program of science instruction.

School buildings are constructed to serve the public for many years and facilities need to be provided that can accommodate constant changes in educational offerings and personnel. Thorough planning, then, not only takes into account the fact that those who are to use the facilities must have a part in their determination, but that those doing the planning think beyond their own personal desires.

Importance of Science in the School Program

At the junior high school and upper elementary levels the students are eager to experiment and solve problems of special interest to themselves. To keep this desire alive it is important that they be provided with the space and facilities to enlarge their experiences by their own activity. They must at the same time gain knowledge and understanding of basic scientific principles and laws of nature.

At the senior high school level students have interests which lead to a greater degree of specialization than in the earlier school years. They need room and equipment to carry on individual and group experimentation in order to become more adept and accurate in problem-solving techniques. A good scientific background is essential to the understanding and appreciation of the impact of scientific advancement on civilization — past, present and future.

Objectives of Science Teaching

Planning adequately for a good program in science will be facilitated if one is aware of the objectives to be met. The following list, though not complete, will point out some of the main objectives of science instruction.

To help the student gain understanding and appreciation of his biological and physical environment

To provide experiences which will promote logical thinking, careful observation and proper problem solving techniques

To develop a realization of the impact of scientific advancement on the student's life and on society

To provide knowledge relative to careers in science and related fields to help the student realize the role of the scientist in the advancement of civilization

To help provide a basis for developing worthwhile leisure activities

The Science Program

The junior high school science program normally consists of seventh, eighth and ninth grade general science. Many schools also offer earth science at the junior high school level.

The program is based on student interests and needs and not on mastery of subject matter alone. Developing the wide variety of interests of junior high school students calls for a wide variety of both individual and group experiences. Student projects, visual aids, clubs, field trips and the use of community resources enrich the science program.

The senior high school science program consists of biology, physics, chemistry and earth science. Many schools also offer courses in biological and physical science to senior high school students as well as advanced courses in science for the 12th grade students. In addition to the five class periods in biology, physics and chemistry, one or two laboratory periods should be provided each week. As at the junior high school level, enrichment is provided through student projects, visual aids, field trips, clubs and use of community resources.

Facilities for Science Instruction

Some general considerations are important in planning science facilities. The program which provides a variety of activities calls for room flexibility. The basic design and arrangement of the room and its furnishings should assure comfort, health, safety and ease of maintenance. The person whose responsibility it is to plan the science

facilities is obligated to seek the help and suggestions from other qualified persons. A careful study of trends in population growth and science enrollment will assist in meeting future needs. If the need for an increase in science facilities is evident within a few years, one or more general classrooms in an area adjacent to the science room should be planned. These rooms should have water, sewer, gas and electrical services roughed-in to points of anticipated need. When roughing-in these services, one should avoid locating them in partitions which may have to be moved.

It is essential that all rooms in which science is taught have an instructor's demonstration desk. Placing this desk on a raised platform will make it easier for all students to view the demonstration and the value gained as a result will offset any maintenance problems experienced by the custodians.

The General Science Room

The general science room should provide 840 square feet of floor space as a minimum and contain facilities for 30 students. Because plant growth and experimentation is an important part of the general science course, the room should be located so as to receive as much sunlight as possible. If possible, the room should be at ground level and located near an exit to make it easy to conduct short field trips and bring materials into the classroom from the outside. It is desirable to have access to roof areas for the use of astronomical and weather equipment and for setting up radio or television antennae.

In small schools, where only one science room is required, a preparation-storage room should be provided adjoining the classroom. When two or more rooms are required, it would be ideal to plan a preparation-storage room for each room.

Every room in which general science is taught should have an instructor's demonstration desk 2½ feet wide and 12 feet long. This desk should be furnished with hot and cold water, a sink, gas and electricity.

The type and arrangement of student furniture will vary with the need of each school. In arrangement, single student desks and chairs are placed at the front of the room and four or six four-student laboratory tables at the back of the room. These laboratory tables should be furnished with water, a sink, gas and electricity. Additional work area may be provided in the form of a work counter along one wall of the room. The work counter should have gas and electrical outlets at five-foot intervals and storage drawers and cupboards below. Additional storage may be had in the form of wall cases above the work counter (figure 1).

In another arrangement 15 two-student tables with chairs and the work counter and wall storage cases, as described above, are placed along one or two walls of the room (figure 2).

The four-student laboratory table might be preferred for the ninth grade science class where more individual-type experimentation is carried on and the two-student table with work counter arrangement for grades 7 and 8.

Each general science and biology room should have a shelf along the window side of the room for plants and displays. A shelf 18 to 24 inches wide is recommended.

Each general science room should be equipped with at least 18 feet of chalkboard and an equal amount of tackboard.

A workbench or table with tools in the science room or adjacent preparation-storage room will make it possible to construct and repair science equipment. Appropriate tools may be selected from a complete list found in *Curriculum Leaflet No. 5, General Science Equipment Inventory.*

An aquarium, terrarium and germinating bed will be important teaching aids and it is recommended that they be portable rather than fixed in the room.

Since the teaching of science is enriched and made easier through the use of film, filmstrips and slides, provisions should be made for darkening the room for this purpose. Pamphlet 8, *Planning Schools for Use of Audiovisual Instructional Materials* contains valuable suggestions for doing this effectively.

The Preparation-Storage Room

Adequate storage space for equipment and supplies is most essential not only from the standpoint of orderliness and safekeeping, but for providing hidden storage for awkward or unsightly objects. Storage facilities should be provided in the classroom as well as in preparation-storage room adjacent to the classroom.

In addition to its use for storage purposes, the preparation-storage room will provide an area for the development of individual and small-group projects by students and assembled equipment may be left several days without disturbance. The instructor will find this room useful for his own experimentations and for setting up class demonstrations in advance. It is recommended that this room be equipped with facilities for making it lightproof. It could then be used for certain light experiments as well as for photographic work, if a separate darkroom is not available. The room should be equipped with a sink which provides both hot and cold water. There should also be a work counter with gas and electrical outlets every five feet.

The Darkroom

The darkroom serves to round out the school program on both the junior and senior high school levels. Students broaden their knowledge of light and its effects and at the same time develop valuable leisure-time activities dealing with photography. The darkroom makes it possible to have a photographic club. It also provides additional storage area.

The minimum area for the darkroom should be 100 square feet. One ceiling light fixture will afford adequate illumination. An incandescent lamp in this fixture will avoid damage to photographic film which might result from the afterglow of a fluorescent lamp. The switch for this fixture should be at some distance from the door so that the person entering will not inadvertently turn on the light. A red light outside the door will also help warn others when the room is in use. It is desirable but not absolutely essential that the walls be coated with a dull black paint. A further protection may be provided in the form of double entrance doors with a small area between so that the outside door may be closed before the inner door is opened.

The nature and extent of the school program in photography will help determine the location of the darkroom. The schools offering courses in photography may want the darkroom adjacent to the photography classroom. Most schools, however, will want the darkroom adjacent to the physics or general science room. In any event the room should be accessible from the corridor.

The darkroom facilities will vary according to the extent and type of activity to be offered.

The following facilities are basic:

1. A developing table with hot and cold water, sink, gas and a double 110 volt a.c. outlet. The table should be equipped for drying prints and film. Cupboards and drawers below the sink and work area will provide some storage.
2. Wall cabinets above the developing table and any other work area will also provide convenient storage.
3. A printing table or work area adjoining the developing table should be of sufficient size to accommodate an enlarger, print drier, print box and balance, in addition to the work surface. The table should also have storage cupboards and drawers below the work area. It is desirable that some of the drawers be lightproof for storing printing paper. Two or three double 110 volt a.c. outlets should be in or near the printing table.

The Biology Room

Biology is not a required course in most schools, yet more students take biology than any other senior high school science course and the enrollments in biology have increased rapidly and steadily for the past several years. It is therefore essential to plan facilities well in advance of the present needs.

A certain amount of laboratory work is required in the biology course and one or two laboratory periods in addition to the five class periods per week should be provided. Combined classroom-laboratory rather than the separate classroom and laboratory are recommended because of the easy transition from classwork to laboratory work as the need arises. Each biology room should be provided with an instructor's demonstration desk 2½ feet wide and 12 feet long. This desk should be furnished with hot and cold water, a sink, gas and electricity.

The biology room or rooms should be located at ground level and near an exit. This arrangement makes it possible for students to engage in short field trips, gardening activities or school grounds improvement without disturbing students in those classes which are going on at the same time.

The biology room should also be located on that side of the building which will provide adequate sunlight for growing plants and animals. A southern exposure is best for growing snakes and most plants, while balanced aquaria and vivaria will do best with northern or eastern exposure.

A decided factor favoring successful growth of plants and animals is keeping the room at an even temperature. To provide for this over weekends and vacation periods it is important that separate and automatic temperature controls for these rooms be incorporated in the initial plans.

Because of the disagreeable odors of some biological preservatives and of plant and animal materials which are not fresh, there should be some form of positive ventilation to prevent recirculation of this air to other rooms.

The minimum area for the biology room should be 840 square feet. The type and arrangement of room furniture as described for general science will be adequate for biology except that microscope storage should be provided.

Each room in which biology is taught should be equipped with at least 18 feet of chalkboard and an equal amount of tackboard.

A separate display case should be installed in the classroom. This case should be equipped with sliding glass doors and a lock. The teacher will find this case valuable for storing and exhibiting mounted and preserved biological specimens.

A preparation-storage room should be built adjoining the classroom or between two classrooms as described for general science. It is desirable that this room be equipped with facilities for making it lightproof to facilitate microprojection. If animals are to be grown in this room direct ventilation to the outside should be provided.

The biology teacher will undoubtedly want to collect and grow animals and plants from the local area for use in his class. An economical way to do this is through the use of aquaria and vivaria — the size and number to be determined by local needs. The smaller, portable types will be found to be more practical than the larger, permanent installations. The teacher will also find a germinating bed an important teaching device. The most effective bed is one which is built on ground since a more even temperature and moisture content can be maintained. The bed should be about 24 inches wide, extend 12 to 16 inches above the floor and be located along the window side of the room. The length of the bed will vary according to need, but it is not practical to install one less than 10 to 12 feet in length. Some schools will find the portable germinating bed more to their liking because of the lower initial cost. A portable bed should not be less than 6 inches in depth because of the extreme variations in temperature and moisture content which may result without constant attention. In many schools the germinating bed is made locally at a minimum of cost. Each bed should be about 6 feet in length, 6 to 10 inches in depth, and zinc lined. Making the front of the box of plate glass will make it possible to observe the root growth of seedlings. The bed should be mounted on four large hard rubber casters so that it can be moved readily.

To provide more satisfactory growing conditions, a local district may want to provide a greenhouse or growing room separated from, but adjacent to the biology classroom. The size and type will be determined by local conditions. As in the case of the biology classroom, it should be located on the south side of the building, or east side as a second choice. Special consideration will need to be given to heating, *ventilation* and humidity control for such a room.

The Physics Room

There is no single arrangement of facilities that can effectively satisfy the needs of all types of learning activities. It is the responsibility of those planning the facilities to provide adequate space and equipment for a wide variety of learning situations and each combination of facilities must take into account the needs of the local community. The combination laboratory-classroom is an effective and economical arrangement. For most effective teaching, the maximum class size should be 24.

The physics room should provide 1,000 square feet of floor space. An instructor's demonstration desk 2½′ x 12′ should be placed in each classroom. This desk should be equipped with hot and cold water, a sink, gas, a.c. and d.c. electrical outlets.

Strong hooks should be anchored in the ceiling for supporting pulleys and heavy equipment. One of these should be in the area of the demonstration desk and a second one may be located elsewhere in the room. Eighteen feet of chalkboard and an equal amount of tackboard should be installed in each physics classroom. Provisions should be made for darkening the room effectively so that audiovisual materials may be used.

Perimeter tables or work counters will provide adequate working area for students. Gas and a.c. and d.c. electrical outlets should be provided for each table or at five-foot intervals along all work counters. The room should have at least one sink, with hot and cold water, in addition to the one in the demonstration table. Drawers and cupboards in the work counters along with wall cabinets above the working area will provide convenient storage.

The physics course requires a variety of electrical services. A panelboard or portable rectifiers should be provided which supply both variable a.c. and d.c. current. Both radio and television antenna should be installed for student experimentation in these fields with convenient outlets from these installations at all work points.

Storage facilities are needed for the large quantity and many types of equipment used in the physics course. A preparation-storage room as described for general science for a single classroom or for each group of two rooms is recommended. Variable a.c. and d.c. electricity will need to be available in this room in addition to the gas and water services. A storage case with sliding glass doors which can be locked and located near the demonstration desk will keep the much used equipment and supplies readily available for demonstration work. Valuable and delicate equipment should be stored in locked cupboards and in an area away from chemicals which may cause corrosion.

The physics course requires a variety of tools and materials because much of the equipment is made and repaired by students. A workbench with appropriate tools should be available for this purpose. One end of the preparation-storage room could be used for this workshop area.

The Chemistry Room

The design of the chemistry room will be determined by the type and arrangement of furniture that it is to accommodate. The room should be planned from a predetermined arrangement of furniture rather than attempting to fit the furniture to the room. The type and amount of furniture in turn will be based on student requirements in relation to community needs.

Special attention must be exercised in selecting chemistry furnishings because of the corrosive action of the materials used in the course. It will therefore be necessary for those planning the facilities to carefully consider the advantages and disadvantages of wood versus metal furnishings. Because of its magnetic properties, it would not be advisable to use metal furniture in combination physics-chemistry laboratory.

As in other science areas, the trend is toward the combination laboratory-classroom. Because of the necessity for providing each chemistry student with facilities for gas, water and electricity, the laboratory furniture will need to be fixed rather than movable. The laboratory sinks should be located so as to require a minimum of moving about on the part of the student.

Whether the chemistry classroom is to be separate from or combined with the laboratory area, it should be equipped with an instructor's demonstration desk 2½ feet wide and 12 feet long. The desk should be supplied with a sink, hot and cold water, gas, alternating current and direct current if available. A laboratory separated from the classroom should have a demonstration desk, but it may be of smaller size and still be adequate.

The classroom should have 18 feet of chalkboard and an equal amount of tackboard. In a separate laboratory 8 to 12 feet of chalkboard along with 6 feet of tackboard will be adequate. There should be provisions for darkening the classroom effectively for the use of audiovisual teaching aids.

There are many possible arrangements of furniture in the laboratory-classroom because of the several different types of laboratory tables available. Most instructors will prefer the arrangement which groups the student desks and chairs in front of the demonstration desk

and leaves the rear or perimeter of the room for laboratory tables. The size of the room will vary according to the type of furniture selected.

The laboratory area should provide water, gas and electricity for each student. All work areas should be treated with paint which resists acids and alkalies. Chemical reagents frequently used should be located within reach of the student. Each student should have a storage drawer for his equipment located at his work area. If the drawers are equipped with locks, a key storage case will be needed and should be located near the room entrance for the convenience of the student.

Special attention will need to be given to the floor or floor covering of the chemistry room. One should be selected which is not easily damaged by acids and other chemicals. It is also important that sink traps and drainpipes be made of a material that is not affected by acids and other corrosive chemicals. Drainpipes should lead directly to the community sewerline. If no sewerline is available, a separate disposal system should be provided so that harmful chemicals do not enter the septic tanks.

To protect the chemistry student and others in the building from harmful gases and obnoxious odors, ventilation as stated in our requirements should be provided. Fume hoods should be installed for this purpose and the portable type will undoubtedly be more functional than the fixed installation.

As in other science areas, storage space is of utmost importance. A storage cabinet with sliding glass doors should be located near the instructor's demonstration desk. Similar wall cabinets may be located along one side of the room. Valuable floor space will be saved if these cabinets are recessed in the wall on the corridor side of the room. Such an arrangement will, however, remove the possibility of locating student corridor lockers in that area. Storage will best be provided by a preparation-storage room of the type described for general science. This room should be equipped with a distilling apparatus and will need an electrical circuit or gasline installed for its operation. A workbench with appropriate tools, located in the preparation-storage room will be useful in constructing and repairing equipment. A separate room for chemical storage is recommended.

First-aid supplies should be readily available in the chemistry laboratory. A shower head and eye wash fountain are valuable precautions. The room should have carbon dioxide fire extinguishers placed at strategic points. As an added safety precaution it may be advisable to provide *two exits* for the chemistry laboratory.

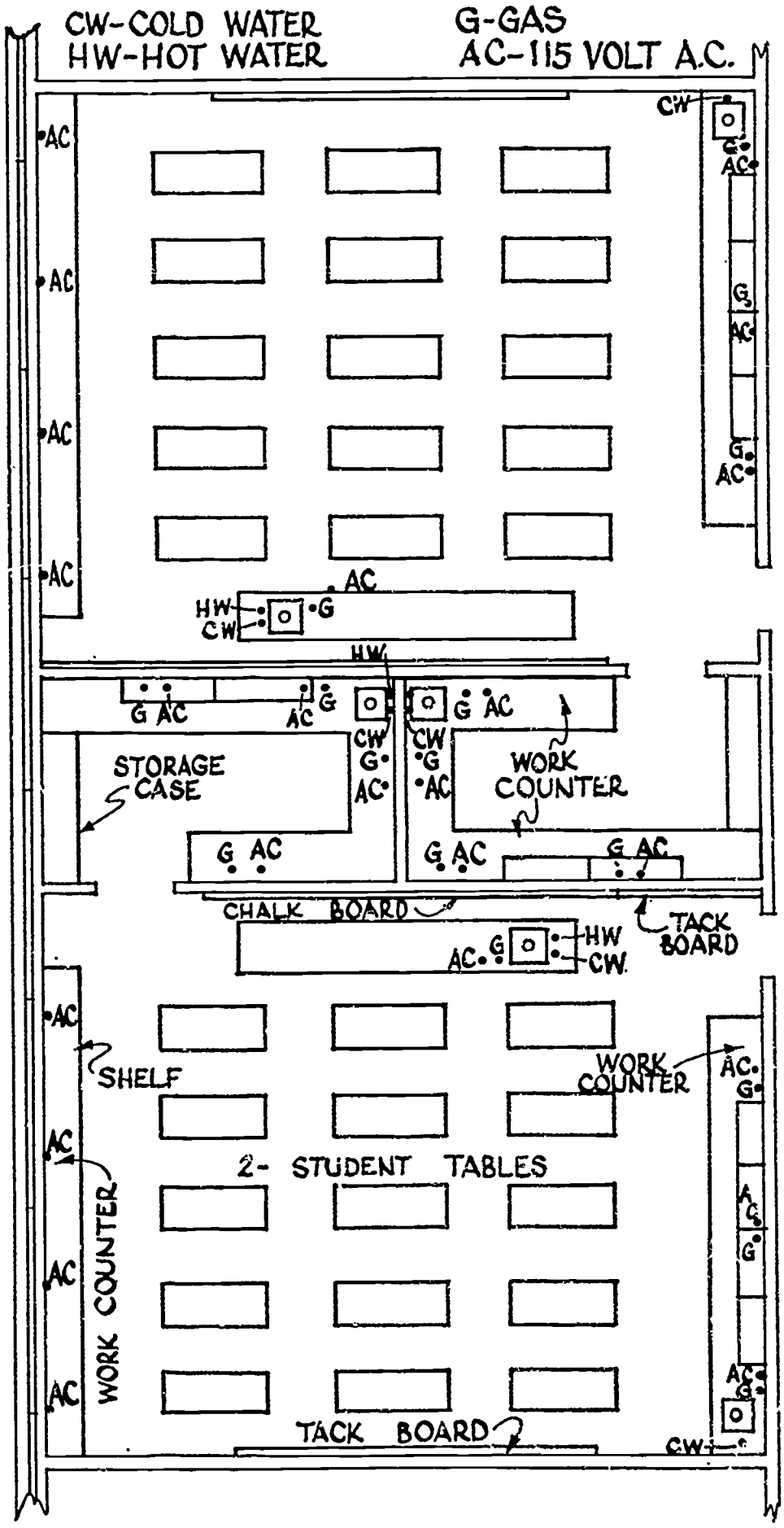

Figure 1. General purpose room

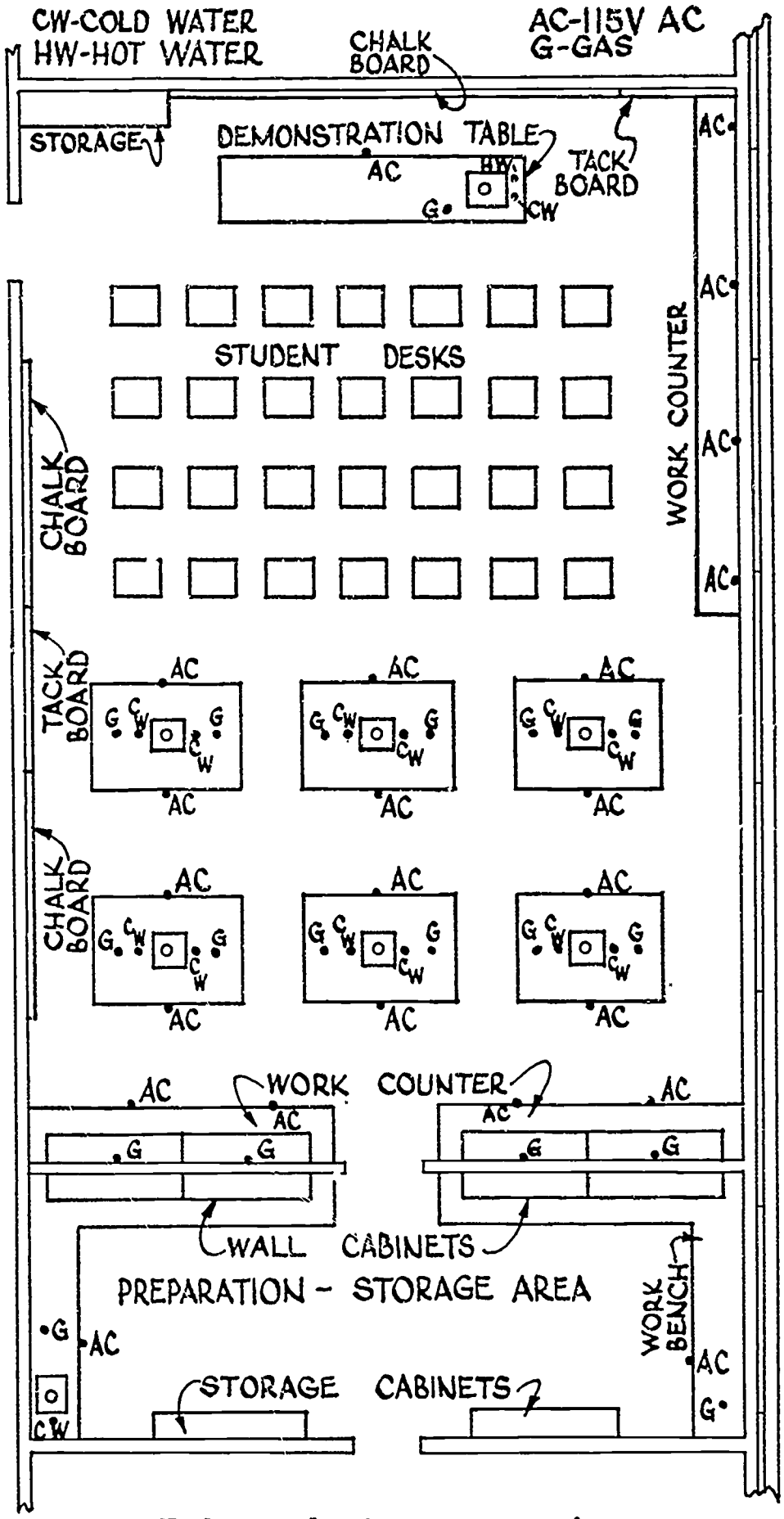

Figure 2. Each room has its own preparation-storage area.